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PermaFoam: using the High Performance Computing capabilities of OpenFOAM for permafrost modeling

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Permafrost is year-round frozen soil that covers a quarter of the lands of the northern hemisphere. Its thawing due to climate change and technogenic perturbations could have significant impacts on cold regions environments, water resources, infrastructures and activities. The cost of permafrost thaw related damages could amount to tens of billions of euros according to a recent study published in *Nature Reviews Earth & Environment* (Hjort et al., 2022). Thus there is a crucial need of accurate, high resolution modeling tools for simulating permafrost dynamics for the anticipation and the mitigation of these damages. This is the main focus of the HiPerBorea project, which aims to assess numerically the impact of climate change on permafrost in four environmental monitoring sites sampling the main boreal biogeoclimatic areas in Eurasia (hiperborea.omp.eu). To this end, we develop permaFoam, the OpenFOAM solver for permafrost modeling (Orgogozo et al., 2019, Orgogozo et al., in revision). In this presentation we detail the latest updates of permaFoam, and show some results of studies of parallel performances done on regional to national level french supercomputing centers (CALMIP, CINES, TGCC). The strong scaling behaviour is excellent up to >16 000 cores. These good parallel capabilities allowed the HiPerBorea project to be granted 7 millions of CPU hours by the GENCI for the period may 2022 – may 2023.

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